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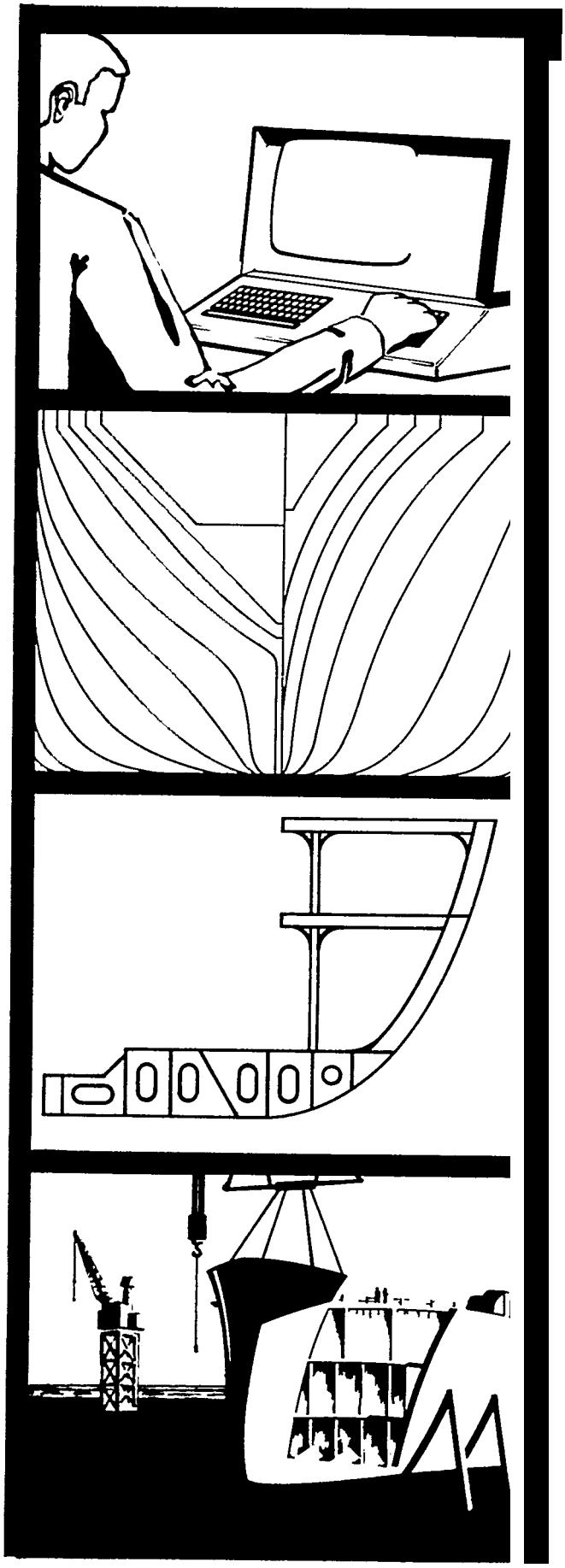

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APPRENTICE--A PORTABLE WELDING ROBOT FOR THE SHIPBUILDING INDUSTRY

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APPRENTICE - A PORTABLE WELDING ROBOT FOR THE SHIPBUILDING INDUSTRY

Introduction

To start with, the title of this paper is not correct: The Apprentice is not a robot! The Apprentice is a programmable welding manipulator, that the operator places where welding has to be done, programs the machine to do the job, and oversees the operation. The operator is in control of the operation, the Apprentice is merely a tool which increases the man's productivity. An industrial robot like the Unimate replaces the man and a Unimate is justified economically by the reduction of wages. The economical justification of the Apprentice is more difficult to specify. Since one man can oversee more than one Apprentice, his productivity is increased and less man hours are required for a given job. The Apprentice should then be justified by the more efficient use of man power, but also other considerations enter the picture. The Apprentice does an excellent job in out of position welding, something I personally cannot do, but I can program an Apprentice to do it - hence, the Apprentice unskills the job of the operator.

It is also willing to work in cramped quarters where heat and fumes make the job unpleasant for a man.

The Apprentice idea goes-back to 1971 when we took a look if our Unimate robot could be applied to the shipbuilding industry at which time we recognized that a stationary robot could do very little in a yard and a different approach was needed.

In 1975 Kockums Shipyard in Sweden showed an interest in our idea and-we jointly arrived. at a specification for the work they were doing building supertankers.

Description

The Apprentice weighs only 35 kg. It has five axes, is an electrically driven and numerically controlled machine. It has a polar coordinate system geometry with the weld torch attached to to the end of the arm.

At programming, a teaching device is placed over the weld torch. On the end of the device, is a wheel which guides the torch and arm along the path to be welded. The wheel generates pulses that trigger the recording of the positions of the five axis.

This same programming device also has a recording switch which is held depressed along the path where the weld is desired.

The welding in a section has to be done in a pre-determined sequence, and the conditions for each weld, such as, speed, weave amplitude, dwell, arc voltage, wire speed, etc., are preset on the control panels of the Apprentice and the welding power supply.

Once the sequence and the weld conditions have been determined, the only thing the operator has to do is to attach the teaching device to the torch, move the torch out of it's resting nest to the location to be first welded, press the wheel against the metal and roll it along the path to be welded while keepinq the weld recording switch depressed, release the switch, move the arm to the next point to be welded, make contact with the wheel, depress the weld recording switch, etc., and finally, place the torch in it's resting nest.

The Apprentice is now programmed and ready for welding. The whole operation only took a minute or two.

Experience to Date

A machine with these features was delivered to Kockums in November 1977 for evaluation. Unfortunately at that time Kockums were no longer building these large ships, and the Apprentice could not be tested in the yard on the job it was initially intended for. Instead, the Apprentice is now being used in building smaller ships.

Originally, at each location, the Apprentice had more than a 2.5 meter of welding to do, which took an arc time of about 50 minutes. In these small ships the weld at each location, is about one meter with a 20 minute welding time. Even with this short welding time Kockums found the Apprentice to be an advantageous tool.

As we have seen earlier the programming is easy and quick. The most time consuming job is to move the Apprentice from one location to the next. Kockums has solved this by using magnetic feet for the Apprentice and slides and other material handling devices to move the Apprentice across the longitudinal stiffners. The power supply, wire feeding equipment, smoke extraction system and the Apprentice control system are placed on a platform that is moved by a Crane to a central location from which the Apprentice can work within a radius only limited by the length of the cables (30 FT.).

We are now building a few pre-production models, some of which have been sold or committed to ship building or other heavy industrial applications. We hope to produce these machines in quantities in about a year from now. The price is estimated to be below $25,000.

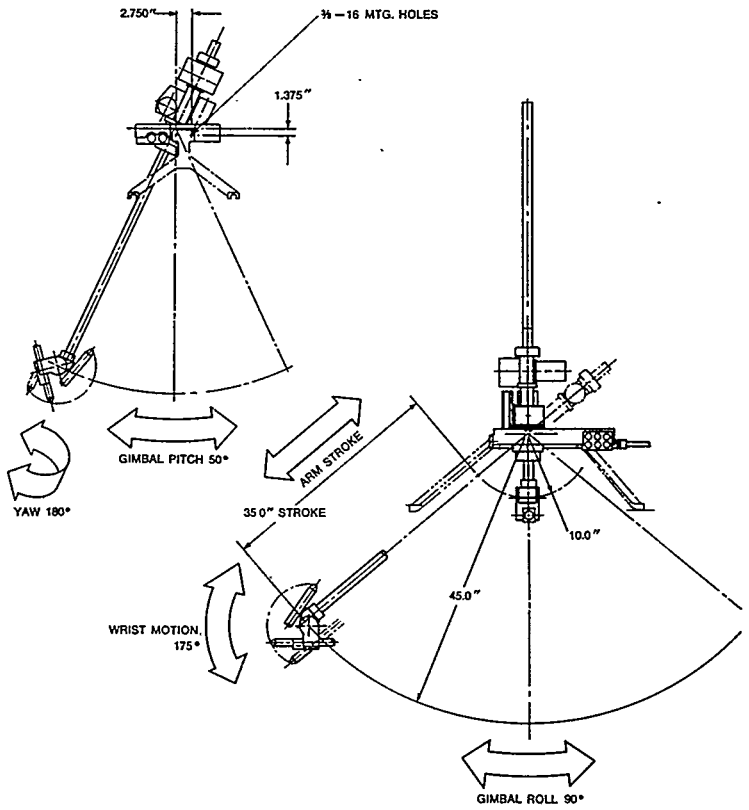
Apprentice Robot Specifications

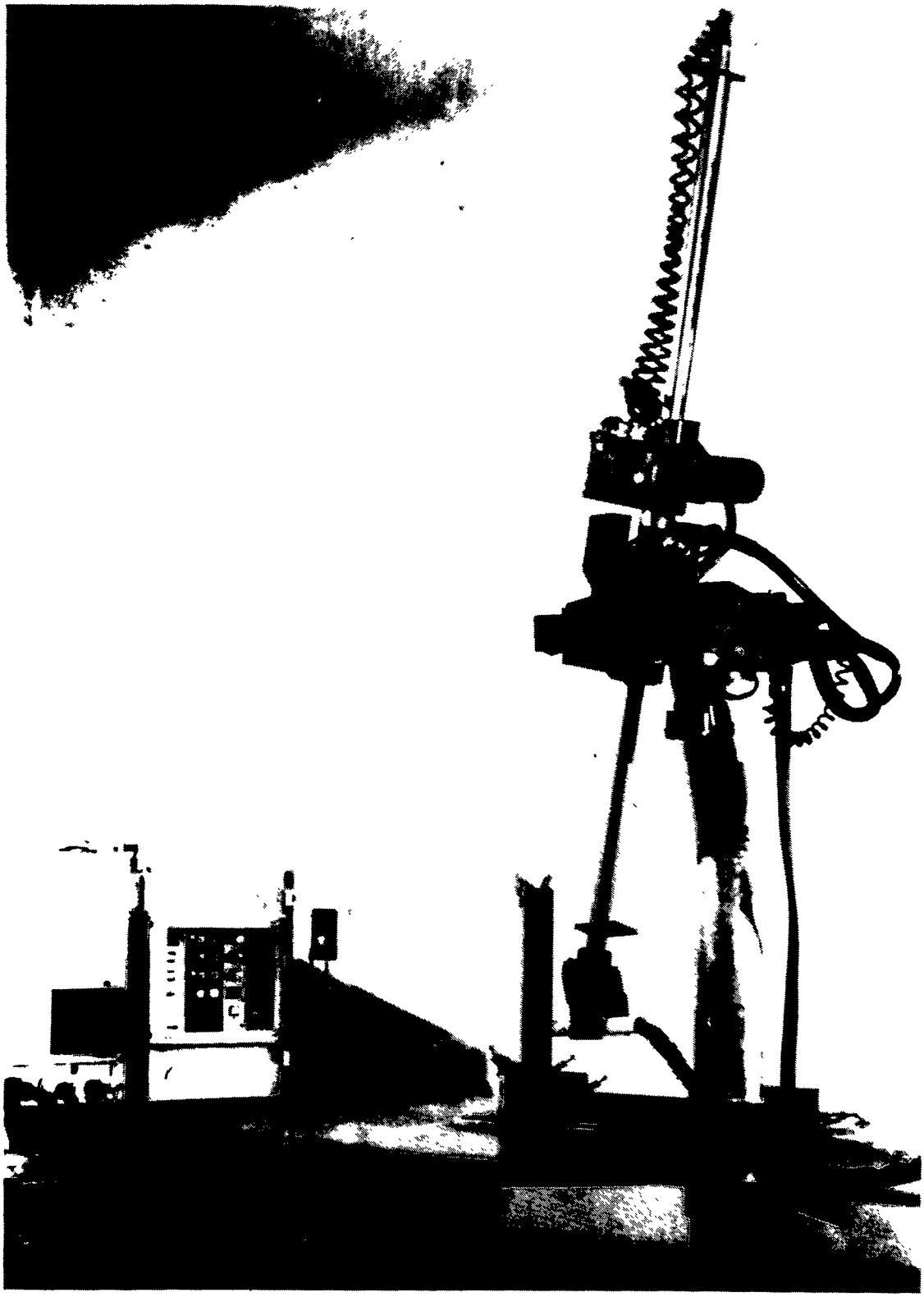
Working Envelope	
Arm stroke	35 inches
Gimbal, roll	90 degrees
Gimbal, pitch	50 degrees
Yaw	180 degrees
Wrist motion	175 degrees

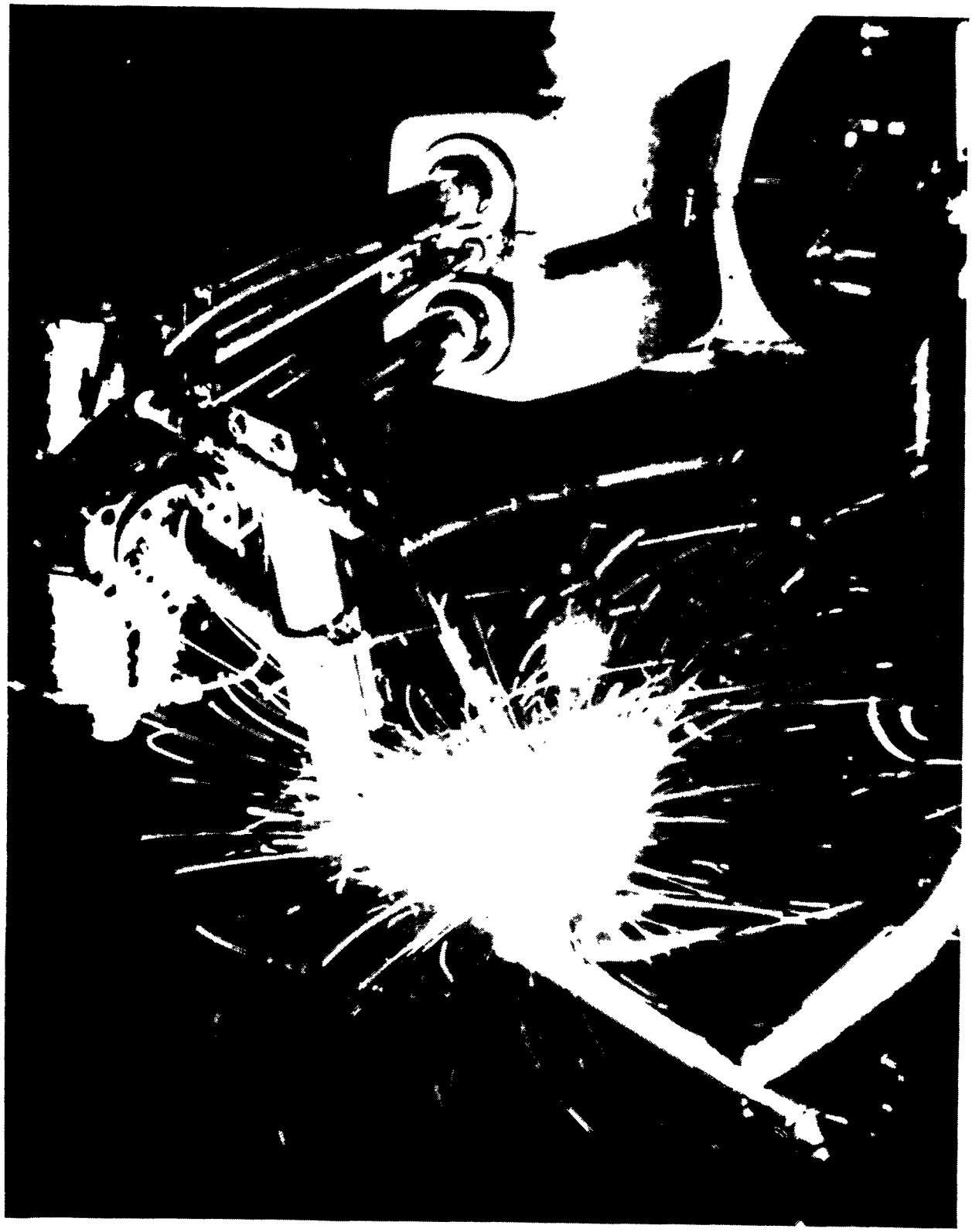
Performance:	
Welding speed	.4 in. to 8 in. per minute
No. of welding speeds	4
No. of preselect welding currents	4
Transfer speed	20 in. per second
Weave Channels	2
Weaving frequency	0.1 per sec. to 1 per sec.
Weaving amplitude	.08 in. to .80 in. peak to peak
Accuracy	± .04 in. max. deviation between taught welding path and the repeated path in automatic welding mode.
Weight of arm	75 lbs.
Weight of cabinet	175 lbs.

Cable length: 33 feet.

Power requirement:
240/480V, +10% −15%: Single phase: 60 Hz; 1KVA (other options available).







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